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ABSTRACT

This packet contains three science learning activities that can be used in agricultural education courses. The activities cover these topics: (1) determining the effects of soil particle size on capillary action; (2) measuring levels of eroded soil particles in streams; and (3) determining the effects of soil cover and texture on surface erosion. The lesson plans for the activities consist of the following elements: agricultural subjects and science principles included in the lesson, agricultural applications, student objectives, activity length, group size, vocabulary, materials required, instructional strategies and procedures (overview and results), key questions, and evaluation. One or two references are given for each activity and each includes data record and observation sheet. (KC)

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AGRICULTURAL EDUCATION SCIENCE ACTIVITY
Nos. SS 2-4

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Agricultural Education Science Activity - No. SS-2

Determining the Effects of Soil Particle Size on Capillary Action

Agricultural Subject

■ Soil Science

Activity Length

■ One class period is required to set up the experiment. Brief observations are required for one to two days.

Group Size

■ This activity can be conducted with an entire class or individual students.

Science Principle

■ **Capillary action:** Although water molecules are attracted to each other and group together, there is a stronger attraction between water and soil molecules. It is called capillary action. This action, which is greater than the pull of gravity, moves water through the soil. Capillary action varies with soil particle size.

Agricultural Application

■ Subirrigation depends on capillary action; therefore, agriculture students need a basic understanding of this process when planning irrigation systems.

Student Objective

■ To determine the effects of soil particle size on capillary action.

Vocabulary

capillary action
field capacity
gravitational water
saturated
hygroscopic
wilting point
soil texture
subirrigation

Materials Required

1. Three glass columns or cylinders (open at both ends)
2. Three small pans or wide-mouth glass jars
3. Thin cloth cut into squares large enough to cover the end of a glass cylinder
4. String or rubber bands
5. Silica sand
6. Clay (dry and ground to a fine powder)
7. Dark crumbly soil (found under sod)
8. Labels
9. Cylinder stand with at least three holes (Constructed so that a cylinder will stand upright when inserted in the stand. Similar to those used to hold test tubes.)
10. Paper and pen for recording results

Instructional Strategies and Procedures

■ **Overview:** Fasten a square of thin cloth over one end of each glass cylinder. Fill each cylinder with a different dry soil. Place the cylinders in a stand with the cloth ends down. Position one glass jar under each cylinder so the cloth end of each cylinder is in a jar. Fill the jars with equal amounts of water. Note the amount of time it takes the water to move up into the cylinders. Record your observations and discuss the results.

Instructional Strategies and Procedures

(continued)

1. Number and label each glass cylinder.
2. Using a rubber band or string, fasten a square of cloth over one end of each glass cylinder.
3. Fill each cylinder three-fourths full with one of the following dry soils:
   a. sand (cylinder one)
   b. clay (cylinder two)
   c. dark crumbly soil (cylinder three)
4. *Gently* tap each cylinder to settle the soil.
5. Place each cylinder (cloth end down) in a stand. Position a wide-mouth glass jar under each cylinder so that the cloth end fits into the jar (see Figure 1).
6. Fill the jars with equal amounts of water. *Do not pour water into the cylinders.*
7. Note the length of time it takes for the water in each jar to move up into the cylinder the following distances:
   a. one inch
   b. two inches
   c. three inches
   d. completely to the top of the cylinder

   Record these times on page 3. If the water never reaches the top of the cylinder, note its maximum height and the amount of time it took to reach this point. Also record this information and other observations on page 3.

■ **Results**: To be determined after trial.

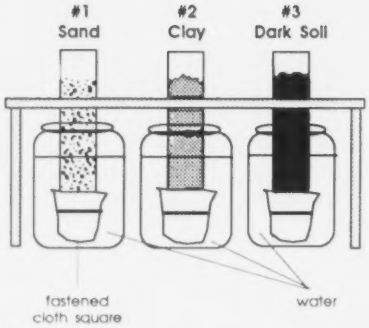

Figure 1. Position a jar under each cylinder.

Key Questions

1. Did the water in all the jars move up into the cylinders at the same rate?
2. Which soil(s) would benefit most from subirrigation?

Evaluation

■ Ask students to write a conclusion based on what they have observed.

Bibliography

Experiment in Soil Science. Vocational Education Productions, California State Polytechnic University. San Luis Obispo, CA.

Related Resource

Miller, C. *Soil and Its Properties* - slide series. ed. F. L. Himes. Columbus, OH: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University, 1988.

Experiment submitted by Tim Niemeyer, Agriculture Education Instructor, Margaretta High School, Castalia, OH 44824.

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DATA RECORD AND OBSERVATION SHEET

Determining the Effects of Soil Particle Size on Capillary Action

Name _____ Date _____ Period _____

Water Height Attained	Water Movement Times and other Observations		
	Sand	Clay	Dark Soil
1 inch			
2 inches			
3 inches			
top of cylinder			
maximum height attained			

Conclusions

Agricultural Education Science Activity – No. SS-3

Measuring Levels of Eroded Soil Particles in Streams

Agricultural Subject

- Soil Science

Activity Length

- Three to six days following a rainfall of one inch or more. Collect control samples before rainfall. (Precede experiment with instruction from a basic soil unit. Include descriptions of soil particles, soil texture, and water erosion.)

Science Principles

- **Sedimentation**: the deposition of soil particles by water, wind, or glaciers.
- **Erosion**: the wearing away of soil particles by the action of water, wind, or glaciers.

Agricultural Application

- During periods of heavy rainfall, surface runoff dislodges soil particles from their original locations. These particles are then placed in suspension. Many are deposited at other locations on the soil surface. Other soil particles stay in suspension and are carried into natural drainage ways (e.g., creeks, streams, and rivers). In time these particles may fall out of suspension and form sediment in the drainage ways. On the other hand, they may be carried to the final outlet and deposited there.

Both erosion losses and sediment deposits are agricultural and environmental concerns. They can affect the wildlife habitat as well as the drinking water supply. Therefore, agriculture students need a basic understanding of soil erosion detection methods in order to prevent these problems.

Student Objective

- To determine and compare the kinds and amounts of suspended soil particles in a moving stream at various time intervals after heavy rainfall.

Group Size

- This activity can be conducted individually or with the entire class.

Vocabulary

erosion
suspension
sample
velocity
watershed
sediment
particle size
organic matter
translucency
opaque

Materials Required

1. Access to a creek, stream, or river with continually flowing water.
2. Heavy rainfall: one inch or more needed to produce sufficient runoff for experiment. (Coordinate experiment with rainfall.)
3. Ten to fifteen clear glass jars of consistent sizes (e.g., baby food jars)
4. Two samples of stream water under normal conditions: one from near the bank and one from midstream (control samples)
5. Labels
6. Shelf storage space for samples
7. Rulers
8. Soil texture and sediment kits (optional - available from *Ward's Biology* - supply catalog)
9. Light source (e.g., bright window light or lamp)
10. Paper and pen for recording results

Instructional Strategies and Procedures

■ **Overview**: Take samples of stream water at various locations and time intervals after a heavy rainfall. Allow the samples to settle. Note sediment layer differences and record results. Discuss the causes of these differences.

1. When the stream is in normal condition, take one water sample at mid-stream and another near the bank. Insert each jar **vertically** into the stream so water can enter from all sides. Label these jars with the sample number and date, time, and location of collection (see Figure 1). Store them on a shelf. These samples serve as controls.
2. Take the remaining water samples following a rainfall of at least one inch. This rainfall should be heavy enough to produce surface runoff and erosion. Take samples at these intervals following the rainfall: 3 hours, 12 hours, 24 hours, and 36 hours. After 36 hours take daily samples as long as desired, or until stream returns to near normal conditions.
3. Next, label these jars with the sample number and date, time and location of collection. Place each sample on a shelf. After 24 hours observe the samples and note the sediment formed. (If quicker results are desired, use a soil testing kit. It contains a reagent to speed the settling process.)
4. Record the color differences of the sediment layers on page 4. Also record the depth of each sediment layer.
5. Determine the translucency of the samples by shaking them simultaneously and then placing them in front of a light source. Note and record the differences on page 4.

■ **Results**: To be determined after trial.

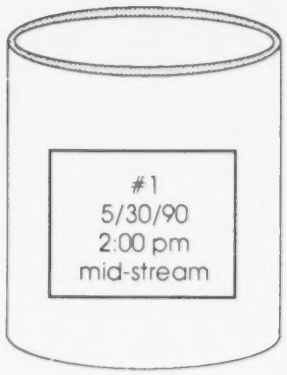

Figure 1. Label each sample jar with the sample number and date, time, and location of collection.

Null Hypotheses

■ There will be no difference in the amount of sediment in samples collected at different time intervals after a heavy rain.

■ There will be no difference in the sediment content in samples collected at different time intervals after a heavy rain.

Evaluation

■ Ask students to write a report based on what they have observed. Include the answers to the key questions.

Key Questions

1. Are the samples collected at mid-stream different than those collected near the bank?
2. At what time interval did you find the greatest amount of sediment?
3. At what time interval did you find the greatest quantity of sand? silt? clay?
4. What keeps the soil particles in suspension?
5. What causes the soil particles to fall out of suspension?
6. What happens to the soil particles in the stream as they fall out of suspension?
7. What are some possible short- and long-term effects of this sedimentation?
8. If the samples had been taken two miles *higher* in the watershed, what might have been the result? two miles *lower*?

References

1. Keith Williamson, District Technician. Hancock County Soil and Water Conservation District, Findlay, OH (personal interview)
2. *Ward's Biology*. 5100 West Henrietta Road, P.O. Box 92912, Rochester, NY. (Telephone orders: 1-800-962-2660 or FAX 716-334-6174)

Experiment submitted by Paul E. Heilman, Production Agriculture Instructor, Cory-Rawson High School, Rawson, OH 45881.

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DATA AND OBSERVATION SHEET

Measuring Levels of Eroded Soil Particles in Streams

Name _____ Date _____ Period _____

Sample Number	Date and Time	Location		Degree of Translucency*	Sediment Levels (Color and Depth)			
		Mid-stream	Edge		Sand	Silt	Clay	TOTAL

* 3 = very translucent, 2 = somewhat translucent, 1 = barely translucent, 0 = opaque

Agricultural Education Science Activity - No. SS-4

Determining the Effects of Soil Cover and Texture on Surface Erosion

Agricultural Subject

■ Soil Science

Activity Length

■ One class period

Group Size

■ This activity can be conducted with the entire class or small groups.

Science Principles

■ Soil surface cover affects the surface erosion caused by runoff.

■ Soil texture affects the surface erosion caused by runoff.

Agricultural Application

■ Soil cover and texture affect soil erodibility. Tillage and cultural practices also affect the soil erodibility by directly influencing the amount of soil surface residue. Eventually these practices affect the soil structure, water infiltration, water percolation, as well as surface runoff. However, by reducing surface runoff and controlling erosion, the soil's long-term productivity is maintained and a cleaner water resource is provided.

Student Objective

■ To determine the effects of different soil textures and soil surface covers on surface erosion and runoff.

Vocabulary

erosion	sediment	surface runoff
residue	infiltration	organic matter
percolation		

Materials Required

1. Sprinkling can
2. Twelve clear glass jars of a consistent size
3. Twelve aluminum loaf pans (3" x 4" x 10")
4. Tin snips or similar cutting tool
5. Labels
6. Water
7. Measuring container
8. Twelve soil samples: Four soil texture groups representing fine, medium, coarse, and muck. Within each texture group there should be three soil samples: one with a sod cover, one with a corn residue cover, and one with no cover.
9. Inclined surface with braces
10. Yardstick
11. Paper and pen for recording results

Instructional Strategies and Procedures

■ **Overview**: Place soil samples in loaf pans having v-shaped notches at one end. Mount and brace each pan on an inclined surface. Position a jar below the notch of each loaf pan. Apply equal amounts of water from consistent heights to the soil samples in the pans. Collect the surface runoff in the jars. Note the contents of the jars and record observations. Develop conclusions based on your observations. Create approved practices for crop residue management and tillage programs.

Instructional Strategies and Procedures

(continued)

1. Using the tin snips, make a v-shaped notch in one end of each loaf pan to permit surface runoff (see Figure 1).
2. Carefully place each soil sample in a separate loaf pan (see suggestions on pages 3 and 4). Number and label each pan with the contained soil cover and texture.
3. Set up an inclined surface with the desired slope (e.g., 2-6%, 6-12%). Mount and brace pan 1 on this inclined surface. Place the pan's notched end at the lower end of the incline.
4. Place a collection jar below the notch of the pan (see Figure 2).
5. Using a sprinkling can, pour water on the soil sample in the pan. (Note the amount of water and the height from which the water was poured.
6. Collect the surface runoff in the jar. Note the amount of erosion that takes place. Record observations on pages 3 and 4.
7. Repeat steps 3 through 6 for the remaining pans. Be certain to fill the sprinkling can with the same amount of water and position it at the same height as you did for pan 1.

■ **Results**: The soil samples with sod and corn residue covers show less erosion than the samples with no cover. Soil texture results will vary depending on soil structure and tilth.

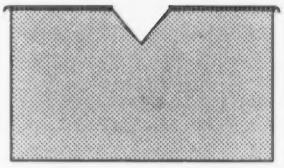

Figure 1. Make a v-shaped notch in one end of each loaf pan.

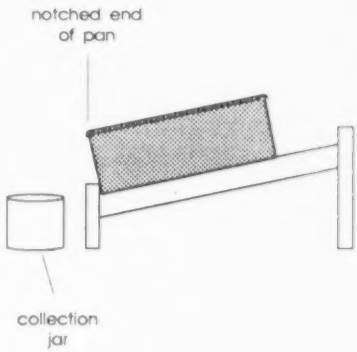

Figure 2. Mount and brace pan on inclined surface. Position collection jar below notch.

Key Questions

1. Which soil covering provides the most protection? the least?
2. Which soil textures resist erosion?
3. Would varied slopes affect the results? How?
4. Would varied water impact intensities affect the results? How?

Evaluation

■ Ask students to develop approved practices for crop residue management and tillage programs based on their observations.

Reference

Keith Williamson, District Technician. Hancock County Soil and Water Conservation District, Findlay, OH (personal interview)

Experiment submitted by Paul E. Heilman, Production Agriculture Instructor, Cory-Rawson High School, Rawson, OH 45881.

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DATA AND OBSERVATION SHEET

Determining the Effects of Soil Cover and Texture on Surface Erosion

Name _____ Date _____ Period _____

Soil Sample	Observations and Comments
#1 Fine texture Sod cover	
#2 Fine texture Corn residue cover	
#3 Fine texture No cover	
#4 Medium texture Sod cover	
#5 Medium texture Corn residue cover	
#6 Medium texture No cover	

DATA AND OBSERVATION SHEET

Determining the Effects of Soil Cover and Texture on Surface Erosion

Name _____ Date _____ Period _____

Soil Sample	Observations and Comments
#7 Coarse texture Sod cover	
#8 Coarse texture Corn residue cover	
#9 Coarse texture No cover	
#10 Muck Sod cover	
#11 Muck Corn residue cover	
#12 Muck No cover	